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**UTILITY  
PATENT APPLICATION  
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(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. Najda 2-8-1 (8018-12)

First Inventor or Application Identifier Najda et al.

Title Reverse Statistical Multiplexing....

Express Mail Label No. EL433-28213US

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

1.  \* Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2.  Specification [Total Pages 28]
  - Descriptive title of the Invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
3.  Drawing(s) (35 U.S.C. 113) [Total Sheets 21]
4. Oath or Declaration [Total Pages 5]
  - a.  Newly executed (original or copy)
  - b.  Copy from a prior application (37 C.F.R. § 1.63(d))  
(for continuation/divisional with Box 16 completed)
    - i.  **DELETION OF INVENTOR(S)**  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

**\*NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).**

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5.  Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
  - a.  Computer Readable Copy
  - b.  Paper Copy (identical to computer copy)
  - c.  Statement verifying identity of above copies

**ACCOMPANYING APPLICATION PARTS**

7.  Assignment Papers (cover sheet & document(s))
8.  37 C.F.R. § 3.73(b) Statement  Power of  
(when there is an assignee)  Attorney
9.  English Translation Document (if applicable)
10.  Information Disclosure Statement (IDS)/PTO-1449  Copies of IDS  
Citations
11.  Preliminary Amendment
12.  Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
13.  Small Entity Statement(s)  Statement filed in prior application,  
(PTO/SB/09-12)  Status still proper and desired
14.  Certified Copy of Priority Document(s)  
(if foreign priority is claimed)
15.  Other: \_\_\_\_\_

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

Continuation  Divisional  Continuation-in-part (CIP) of prior application No: \_\_\_\_\_

Prior application information: Examiner \_\_\_\_\_ Group / Art Unit: \_\_\_\_\_

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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IN THE UNITED STATES  
PATENT AND TRADEMARK OFFICE

PATENT APPLICATION

Joseph J. Najda, D. Reagan Rice, Allen M. Rush

CASE: Najda 2-8-1 (8018-12)

TITLE: REVERSE STATISTICAL MULTIPLEXING TO ACHIEVE EFFICIENT  
DIGITAL PACKING WITH LINK PROTECTION

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09/446649  
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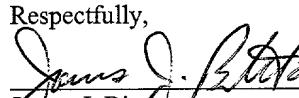
Enclosed are the following papers relating to the above-named application for patent:

28 sheets Specification, Claims and Abstract  
2 sheets of Informal drawings  
4 sheets Assignment with Cover Sheet  
5 sheets Declaration and Power of Attorney

CLAIMS AS FILED				
	NO. FILED	NO. EXTRA	RATE	CALCULATIONS
Total Claims	23 - 20 =	3	x 18 =	\$ 54.00
Independent Claims	3 - 3 =	0	x 78 =	\$ 0.00
Multiple Dependent			x 260 =	\$
Basic Fee				\$ 760.00
				<b>Total Fee: \$ 814.00</b>

Please file the application and charge Lucent Technologies Deposit Account No. 12-2325 the amount of \$814.00, to cover the filing fee. **Duplicate copies of this letter are enclosed.** In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit Deposit Account No. 12-2325 as required to correct the error.

Please address all correspondence to **Frank Chau, F. Chau & Associates, LLP, 1900 Hempstead Turnpike, Suite 501, East Meadow, New York 11554**. However, telephone calls should be made to me at (516) 357-0091.

Respectfully,  
  
James J. Bitetto  
Reg. No. 40,513  
Attorney for Applicant(s)

Date: November 30, 1999  
Lucent Technologies, Inc.  
600 Mountain Avenue  
P.O. Box 636  
Murray Hill, New Jersey 07974-0636

CERTIFICATION UNDER 37 C.F.R. § 1.10

I hereby certify that this Application transmittal and the documents referred to as enclosed are being deposited with the United States Postal Service on this date November 30, 1999 in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL433928213US addressed to: Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231.

  
James J. Bitetto

REVERSE STATISTICAL MULTIPLEXING TO ACHIEVE  
EFFICIENT DIGITAL PACKING WITH LINK PROTECTION

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to digital networks, and  
more particularly to a ring configured system for  
efficiently packing data while restoring service in the  
event of a failure.

2. Description of the Related Art

Synchronous Optical Network (SONET) configurations  
available commercially from Lucent Technologies, Inc., using  
for example, DDM-2000 equipment, can provide service using a  
ring configuration which permits a multiplicity of de-  
multiplex sites, each feeding a customer location, and also  
provides protection switching for the SONET equipment to  
restore service in the event of a failure of one link in the  
optical network.

Unfortunately, this combination of features cannot be readily applied to service configurations using Asynchronous Transfer Mode (ATM) transmission of broadband signals, such as those using Internet Protocol (IP), without having to 5 deploy extra units of digital bandwidth, many of which are not fully utilized. This situation constitutes an economic barrier to the hoped-for deployment of several ATM transmission systems that will provide greater speed for the download of digital data to Internet end customers. The 10 additional equipment also increases system complexity and handling.

Therefore, a need exists for a multiplexing apparatus and method congruous with ATM transport networks in a SONET ring network that includes the capability of 15 restoring service and maintaining transferred data in the event of a failure of one or more links in the SONET ring.

#### SUMMARY OF THE INVENTION

An asynchronous transfer mode network, in accordance 20 with the present invention, includes a plurality of remote terminals remotely disposed relative to a central office.

The remote terminals are connected by a ring with two paths. The ring transfers signals thereon in opposite directions relative to each path. The central office feeds duplicate signals on each path. Each remote terminal includes a first 5 multiplexer for routing signals transferred on the ring to and from an asynchronous feeder multiplexer. The asynchronous feeder multiplexer is adapted to route components of downstream signals on a first path of the ring to a destination and to replace the components of the 10 signals on the first path with copies of components of signals running in an opposite direction on a second path of the ring such that at any location in the network both paths provide all signals.

Another asynchronous transfer mode network of the 15 present invention includes a first path for connecting a plurality of remote terminal sites and for transferring asynchronous transfer mode signals in a first direction and a second path for connecting the plurality of remote terminal sites and for transferring asynchronous transfer mode signals in a second direction opposite the first 20 direction. A central office is coupled to the first and

second paths for feeding duplicate asynchronous transfer mode signals downstream from the central office to the remote terminal sites and for receiving upstream asynchronous transfer mode cells from the remote terminal sites to compare upstream signals and to select a best available upstream signal. The remote terminal sites include a first multiplexer for routing signals transferred on the first and second paths to and from an asynchronous feeder multiplexer. The asynchronous feeder multiplexer is adapted to route components of downstream signals on the path to a destination and to replace the components of the signals on the first path with copies of components of signals running in an opposite direction on the second such that at any location in the network both paths provide all signals.

In alternate embodiments, the asynchronous feeder multiplexer may include protection logic adapted to compare signals received from the opposite directions on the two paths to select a signal to be output. The protection logic may select for the output that signal which remains after a loss of signal has been detected. The protection logic

selects, for the output signal, a signal having a best signal quality, e.g., the least number of bit errors. The signals received from opposite directions may include components and the protection logic may selectively choose or merge components of each output signal based on the components having a best signal quality. The network may include a synchronous optical network (SONET) with at least an STS-1 optical bandwidth. The network may include metallic channels in the two paths of the ring, with for example, a DS3 bandwidth.

A method for providing add/drop capability and link protection in an asynchronous network of the present invention includes providing an asynchronous transfer mode network having a plurality of remote terminals remotely disposed relative to a central office. The remote terminals are connected to a ring including two paths which transfer signals thereon in opposite directions relative to each path. Duplicate signals are fed downstream on each from the central office. The signals transferred on the two paths are routed to and from an asynchronous feeder multiplexer at each remote terminal. Components of downstream signals on a

first path of the ring are routed to a destination, and the components of the signals on the first path of the ring are replaced with copies of components of signals running in an opposite direction on a second path of the ring such that at any location in the network both paths provide all signals.

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In other methods, the step of comparing signals received by the central office from opposite directions on the two paths to select an output signal may be included. The step of comparing signals may include the step of selecting the output signal which remains after a loss of signal has been detected. The step of comparing signals may include the step of selecting the output signal which includes a best signal quality. The step of comparing signals may include the step of merging components of each signal based on the components including a best signal quality.

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These and other objects, features and advantages of the present invention will become apparent from the following detailed description of illustrative embodiments thereof, which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be described in detail in the following description of preferred embodiments with reference to the following figures wherein:

5 FIG. 1 is a block/flow diagram showing a network/data flow for an asynchronous digital network in accordance with the present invention; and

10 FIG. 2 is a block/flow diagram showing an ATM feeder multiplexer and data flow in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention includes a system and method whereby a multiplexer, preferably a statistical multiplexer 15 (SM), part of an asynchronous transfer mode (ATM) transport network, is designed not only to read out downstream ATM cells (traffic) destined for that location but also to insert (write) into those same cell locations, that continue downstream toward the next site in the ring, copies of the 20 corresponding traffic destined for upstream transport. The SM also receives, in the upstream direction, ATM cells

that are identical in content to those downstream cells to be read out. The SM is designed to choose, for the downstream traffic the SM sends to its subtended elements, between the downstream cells it receives in the "normal" downstream direction and those it receives in the normal upstream direction. The SM makes its choice on the quality of the ATM cells' content. A link failure will allow the SM to make a clear decision in favor of the cells that have passed through the good segments of the ring.

Regarding ATM cells headed upstream, the SM feeds identical copies of the cells it receives from its subtended elements into the normal upstream transport path and also into the normal downstream path as mentioned. At the hub end of the ring, where duplicate copies of the ATM traffic are normally received from opposite directions on the ring, the transport equipment can select the received leg that has not suffered a transmission failure, not suffered from a decrease in transmission quality or is consistent with a default choice when there is no failure or quality problem.

The invention permits for a single digital rate signal, such as, for example, one at the third level (Digital Signal

3 (DS3) over a metallic channel, STS-1 when converted to  
optical format), to carry traffic at full capacity,  
supplying the several SMs at their downstream sites with ATM  
cells that begin their downstream journey fully packing the  
5 cell capacity of, for example, the STS-1 component of the  
optical facility. It should be noted that Digital Signal 1  
(DS1) or other levels may also be employed for electrical or  
optical transmission.

At each downstream site ATM cells are dropped off to  
10 the subtended elements (e.g., remote terminals), until at  
the last site in that direction the remaining ATM cells are  
dropped off. Wherever ATM cells are dropped, those cell  
positions are replaced with copies of upstream cell traffic.

In the event of a link failure (e.g., fiber/cable cut) all  
15 the ATM cells designated for each site are still available  
for accurate reception by the SM at that site, and all the  
ATM cells transmitted upstream are available for reception  
by the ATM network element at the central office end.

The prior art for effecting link protection on a ring  
20 with multiple downstream sites ("add/drop" capability)  
depends on a traffic format that is based on dividing the

transmitted signal into its fixed DS1 or DS3 components.

Advantageously, the ATM service application of the present invention includes a digital format with capacity, which is dynamic, that is, a portion of the downstream signal can be dropped off at a site and the site/cell map can be changed easily and remotely. Further, the digital format can be an extension of existing ATM technology.

The present invention permits existing ring networks with deployed remote terminals of digital loop carrier (DLC) systems to support the enhancement of the DLCs to provide broadband transport of ATM protocol signals. These ATM protocol signals may be used to offer much faster downloading of information, such as, for example, Internet graphics. The present invention permits a service provider, such as, a telephone company, to operate a network adding ATM capability without being forced to expand the costly cable facilities comprising the network. The present invention may be employed, for example, in the AnyMedia Access System, the SLC-2000 Access System, and the SLC Series 5 Carrier System DLCs.

Referring now to the drawings in which like numerals represent the same or similar elements and initially to FIG. 1, an information transfer network 10 is illustratively shown for one embodiment of the present invention.

5 Information transfer network 10 may include a central office 12 where incoming and outgoing connections are routed to one or more data transfer networks. Information transfer network 10 preferably includes a ring 14 for data transfer to occur.

10 Ring 14 preferably includes a synchronous optical network (SONET) ring; however, electrical rings may be employed.

Ring 14 includes an upstream flow (upstream) and a downstream flow (downstream) to provide redundant data packets or cells traveling through network 10. Upstream or downstream is referenced relative to central office 12.

15 Information leaving central office 12 travels downstream, while information traveling to the central office 12 is traveling upstream.

In accordance with the present invention, an asynchronous transfer mode (ATM) cell-based signal is applied to ring 14 from an ATM network 18 which connects 20 from an "edge" element such as an ATM router.

Multiplexers 16, preferably, ATM feeder multiplexers (AFMs), are employed to route information in cells in both the upstream and the downstream directions. In a preferred embodiment, a uni-directional path switched ring (UPSR) 15 including two paths carrying oppositely directed signals is employed, which achieves both add/drop and link protection capability in accordance with the invention. Both features are achieved by employing multiplexers 16 in accordance with the invention at each remote terminal site 20. Each site 20 may include a location where information cells carried by network 10 are received (i.e., the destination of the data). Each multiplexer 16 is employed at each site 20 with a multiplexer 22, preferably a digital data multiplexer (DDM). Multiplexers 16 may be employed as terminals of an optical fiber network or an electrical network (e.g., using copper cable). An example of ATM feeder multiplexer (AFM) may include an LPA900 AFM-DS3 available commercially from Lucent Technologies, Inc., which is enhanced to support the present invention.

20 Multiplexer 16 is adapted for ATM transfers in, for example, a synchronous network (e.g., SONET) in ring 14.

Multiplexers 22 may include, for example, a DDM 2000 available commercially from Lucent Technologies, Inc.

Beginning at central office 12 and following two downstream paths, downstream signals are double fed into ring 15 in opposite directions. An information component or "cell", signal  $D_{123}$ , is directed down ring 15 to multiplexer 22 at site  $20_1$  and is processed by multiplexer 16<sub>1</sub>. The cell delivers a portion of its contents to site  $20_1$  and outputs cell  $D_{23}U_1$ . In this way, a portion of the information  $D_1$  is supplied to its destination site  $20_1$  and upstream information  $U_1$  passing through site  $20_1$  is incorporated into the cell position previously occupied by  $D_1$ .  $D_{23}U_1$  is multiplexed and transferred to a next site  $20_2$ . At site  $20_2$ , multiplexer 22 outputs  $D_{23}U_1$  to multiplexer 16<sub>2</sub>, where  $D_2$  is received at site  $20_2$  and upstream contents  $U_2$  are received and installed in place of  $D_2$ . A new composite cell is output to multiplexer 22 as  $D_3U_{12}$ . Again, information addressed for the given site  $D_2$  is received at the site and the contents of the cell are replaced with  $U_2$ ;  $U_2$  is also launched onto the ring with information flow in the opposite direction.  $D_3U_{12}$  is received by multiplexer 22 at site  $20_3$  and

At central office 12, information signals that were  
duplicated and sent downstream in the opposite direction as  
described above, are now described. Processing of the  
signals is provided as above except at site 20<sub>3</sub>; D<sub>123</sub> is  
input, and D<sub>12</sub>U<sub>3</sub> is output. At site 20<sub>2</sub>, D<sub>12</sub>U<sub>3</sub> is input, and  
D<sub>1</sub>U<sub>23</sub> is output. At site 20<sub>1</sub>, D<sub>1</sub>U<sub>23</sub> is input and U<sub>123</sub> is output  
and returned to central office 12. U<sub>123</sub> from both directions  
are received in multiplexer 22 of central office 12. Both  
U<sub>123</sub> signals are compared for each component, e.g., U<sub>1</sub> and U<sub>1</sub>  
are compared, U<sub>2</sub> and U<sub>2</sub> and U<sub>3</sub> and U<sub>3</sub>, etc. Multiplexer 16<sub>co</sub>  
is employed for comparing the signals and selecting the  
"healthiest" one, i.e. the signal with fewer bit errors. An  
automatic protection switch (APS) or logic device 17 may be

included on each multiplexer 16 to determine the best signal or signal component of between the two paths of ring 15 for delivery to the destination of the data. The components of each signal may be merged to form a best resultant signal or 5 simply to select a remaining signal if one uni-directional path of ring (UPSR) 15 fails, e.g., a fiber or wire break. The selected output signal  $U_{123}'$  may then be sent to other networks.

Referring to FIG. 2, an ATM feeder multiplexer (AFM) 16 10 is shown in greater detail. AFM 16 includes an ingress port 102 and an egress port 104 for a first side 106 of ring 15. First side 106 corresponds with a portion of one path of 15 uni-directional path switched ring 15 (FIG. 1). A second side 108 includes an ingress port 110 and an egress port 112 which provides a portion of the other path of uni-directional path switched ring 15 (FIG. 1). A plurality of connections 114 provide appropriate input and output connections for multiplexer 16 at an ATM layer to provide the appropriate cross-connections for transferring 20 information between upstream and downstream paths as described above. Multiplexer 16 interfaces with a line card

116, for example, an asynchronous digital subscriber line card (ADSL) plug-in such as one coded LPA400 available commercially from Lucent Technologies, Inc.

In accordance with the invention, whatever downstream 5 ATM cells are read and sent to the ADSL line cards 116 are replaced by corresponding upstream ATM cells from the same set of line cards 116. This feature of the present invention provides a unidirectional path switched ring (UPSR) which has the capabilities for add/drop of cells and 10 link protection in which information is redundantly available at each site.

At the physical layer 100, physical signal ingress is monitored and loss of signal or AIS (Alarm Indication Signal) is reported to switches for making proper connection 15 to select the "healthiest data" as will be described. "Healthy criteria" include bipolar violation and loss of signal (LOS) at the DS3 level, and/or misrouted cells and header check error at the ATM layer. At the ATM layer cells are monitored for virtual connection ingress and a report is 20 issued if an indication of a virtual path-AIS (VP-AIS) or virtual channel-AIS (VC-AIS) condition is detected.

ATM pass-through switches 120 are included in multiplexer 16. ATM pass-through switches 120, which operate on ATM cells that are not destined for drop-off at this site, are employed as follows. If a physical signal failure, for example, a DS3 LOS, is detected at the ingress 102 of first side 106, then ATM alarm information is sent from the ingress 102 of first side 106 to the egress 112 of second side 108. If a physical signal failure is detected at the ingress 110 of second side 108, then ATM alarm information from the ingress 110 of second side 108 is sent to the egress 102 of first side 106. If no physical failures are detected, then ATM cells are passed-through to the egress of the same side.

ATM cross-connections 122 are employed to bridge the egress 104 of first side 106 to the egress 112 of second side 108. ATM cross-connections 122 are also employed to select between ingress 102 and ingress 110 based on the detected physical ingress state of cells received. Multiplexer 16 is capable of selecting the valid downstream signal from the ATM signals going in both upstream and downstream directions. Protection logic 17 provides decision

making logic to select between duplicate signal components to provide the best signal. Logic 17 may include a default setting which is changed if loss of signal or an alarm indication signal is triggered, or a decision may be made 5 based on signal analysis provided by logic 17. Logic 17 receives DS3 level alarm information from both physical layers 100, and ATM alarms from ATM cross-connection device 118 and conveys its conclusions to pass-through switches 120 and ATM cross-connections 122. Logic 17 may be included as 10 part of cross-connection device 118. Logic 17 may be employed at remote stations to compare components of the signals traveling along ring 15. In this way, a best signal is chosen for delivery at its destination. For example, logic 17 may be employed to compare  $D_3$  of  $D_{123}$  and  $D_3$  of  $D_3U_{12}$  15 at site 20, of FIG. 1.

Advantageously, the present invention permits efficient data packing by filling locations vacated by data delivered at a site with data to be sent upstream. By properly selecting the data which is used to replace delivered data, 20 the present invention provides link protection. The data present at any location on ring 15 is cumulatively all the

signals on the network, such that despite the several data exchanges, the dual ring has complete continuity. In the event of a failure, no data is lost since the data for a location is available in duplicate at all remote terminals.

Having described preferred embodiments of a system and method of reverse statistical multiplexing to achieve efficient digital packing with link protection (which are intended to be illustrative and not limiting), it is noted that modifications and variations can be made by persons skilled in the art in light of the above teachings. It is therefore to be understood that changes may be made in the particular embodiments of the invention disclosed which are within the scope and spirit of the invention as outlined by the appended claims. Having thus described the invention with the details and particularity required by the patent laws, what is claimed and desired protected by Letters Patent is set forth in the appended claims.

WHAT IS CLAIMED IS:

1. An asynchronous transfer mode network comprising:

a plurality of remote terminals remotely disposed relative to a central office, the remote terminals being connected by a ring with two paths which transfers signals thereon in opposite directions relative to each path, the central office for feeding duplicate signals on each path;

5 each remote terminal including:

a first multiplexer for routing signals

10 transferred on the ring to and from an asynchronous feeder multiplexer; and

the asynchronous feeder multiplexer adapted to route components of downstream signals on a first path of the ring to a destination and to replace the components of 15 the signals on the first path with copies of components of signals running in an opposite direction on a second path of the ring such that at any location in the network both paths provide all signals.

20 2. The network as recited in claim 1, wherein the asynchronous feeder multiplexer includes protection logic

adapted to compare signals received from the opposite directions on the two paths to select a signal to be output.

3. The network as recited in claim 2, wherein the  
5 protection logic selects for the output that signal which remains after a loss of signal has been detected.

4. The network as recited in claim 2, wherein the  
10 protection logic selects, for the output signal, a signal having a best signal quality.

5. The network as recited in claim 2, wherein the  
signals received from opposite directions include components and the protection logic selectively chooses components of  
15 each output signal based on the components having a best signal quality.

6. The network as recited in claim 1, wherein the network includes a synchronous optical network (SONET).

7. The network as recited in claim 6, wherein the network employs at least an STS-1 optical bandwidth.

8. The network as recited in claim 1, wherein the  
5 network includes metallic channels in the two paths of the ring.

9. The network as recited in claim 8, wherein the network employs DS3 bandwidth.

10  
10 10. An asynchronous transfer mode network comprising:  
a first path for connecting a plurality of remote terminal sites and for transferring asynchronous transfer mode signals in a first direction;  
15 a second path for connecting the plurality of remote terminal sites and for transferring asynchronous transfer mode signals in a second direction opposite the first direction;  
a central office coupled to the first and second paths for feeding duplicate asynchronous transfer mode signals downstream from the central office to the remote

terminal sites and for receiving upstream asynchronous transfer mode cells from the remote terminal sites to compare upstream signals and to select a best available upstream signal;

5 the remote terminal sites including:

a first multiplexer for routing signals transferred on the first and second paths to and from an asynchronous feeder multiplexer; and

the asynchronous feeder multiplexer adapted

10 to route components of downstream signals on the path to a destination and to replace the components of the signals on the first path with copies of components of signals running in an opposite direction on the second path such that at any location in the network both paths provide all signals.

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11. The network as recited in claim 10, wherein the central office includes an asynchronous feeder multiplexer including protection logic adapted to compare signals received from opposite directions on the first and second paths to select the best available upstream signal.

12. The network as recited in claim 11, wherein the protection logic selects the best available upstream signal by selecting a signal which remains after a loss of signal has been detected.

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13. The network as recited in claim 11, wherein the protection logic selects the best available upstream signal by selecting a signal having a best signal quality.

10 14. The network as recited in claim 11, wherein the signals received from opposite directions include components, and the protection logic selectively merges components of each of the signals received from opposite directions based on a condition of best signal quality.

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15. The network as recited in claim 10, wherein the network includes a synchronous optical network (SONET).

20 16. The network as recited in claim 15, wherein the network employs at least an STS-1 optical bandwidth.

17. The network as recited in claim 10, wherein the network includes metallic channels in the first and second paths.

5 18. The network as recited in claim 17, wherein the network employs DS3 bandwidth.

10 19. A method for providing add/drop capability and link protection in an asynchronous network comprising the steps of:

15 providing an asynchronous transfer mode network having a plurality of remote terminals remotely disposed relative to a central office, the remote terminals being connected by a ring including two paths which transfer signals thereon in opposite directions relative to each path;

feeding duplicate signals downstream on each path from the central office;

20 routing signals transferred on the two paths to and from an asynchronous feeder multiplexer at each remote terminal;

routing components of downstream signals on a first path of the ring to a destination; and replacing the components of the signals on the first path of the ring with copies of components of signals running in an opposite direction on a second path of the ring such that at any location in the network both paths provide all signals.

20. The method as recited in claim 19, further comprising the step of comparing signals received by the central office from opposite directions on the two paths to select an output signal.

21. The method as recited in claim 20, wherein the step of comparing signals includes the step of selecting the output signal which remains after a loss of signal has been detected.

22. The method as recited in claim 20, wherein the  
20 step of comparing signals includes the step of selecting the  
output signal which includes a best signal quality.

23. The method as recited in claim 20, wherein the  
step of comparing signals includes the step of merging  
components of each signal based on the components including  
5 a best signal quality.

ABSTRACT OF THE DISCLOSURE

An asynchronous transfer mode network, in accordance with the present invention, includes a plurality of remote terminals remotely disposed relative to a central office.

5      The remote terminals are connected by a ring with two paths. The ring transfers signals thereon in opposite directions relative to each path. The central office feeds duplicate signals on each path. Each remote terminal includes a first multiplexer for routing signals transferred on the ring to  
10     and from an asynchronous feeder multiplexer. The asynchronous feeder multiplexer is adapted to route components of downstream signals on a first path of the ring to a destination and to replace the components of the signals on the first path with copies of components of signals running in an opposite direction on a second path of  
15     the ring such that at any location in the network both paths provide all signals.

III 6. 4

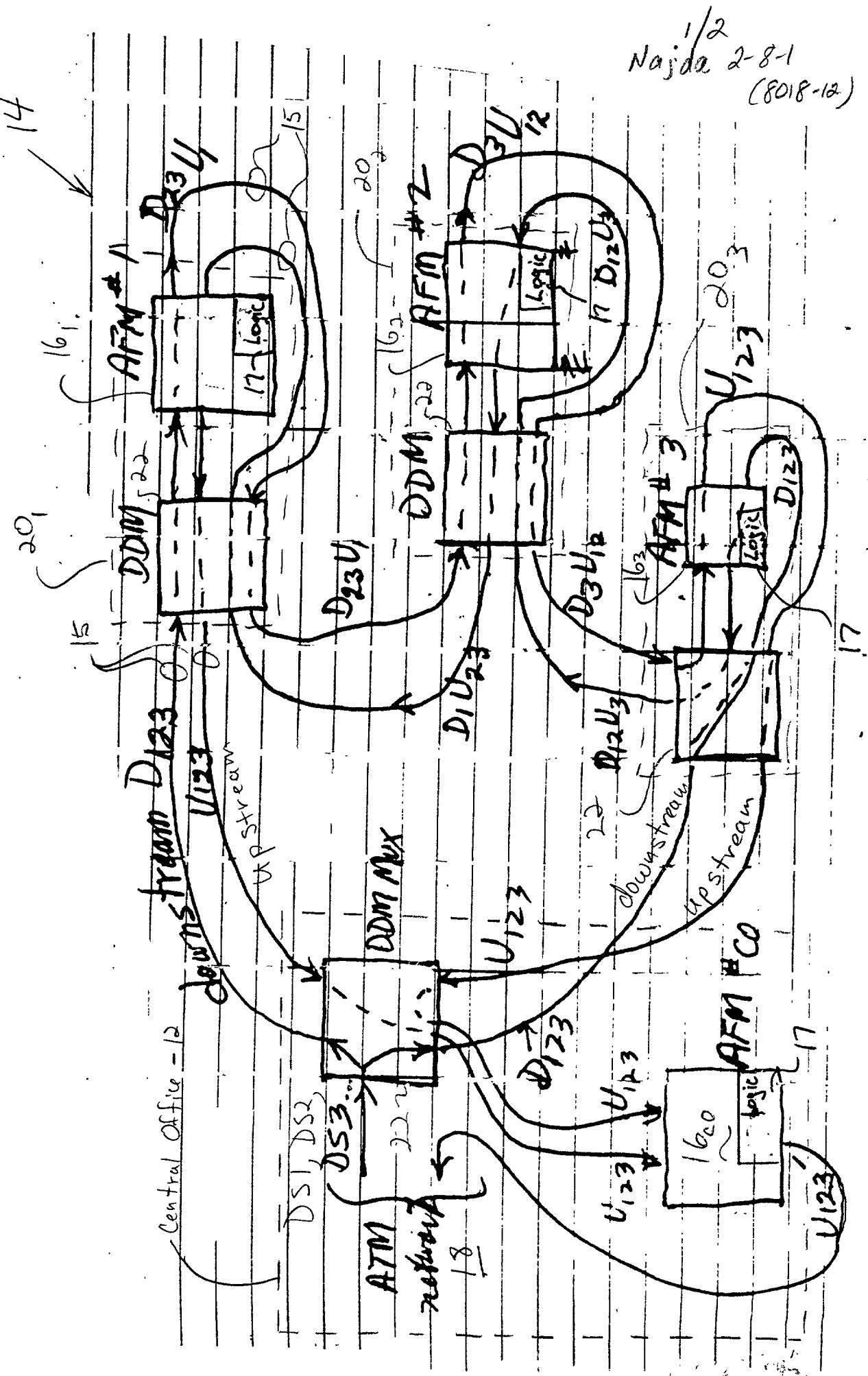
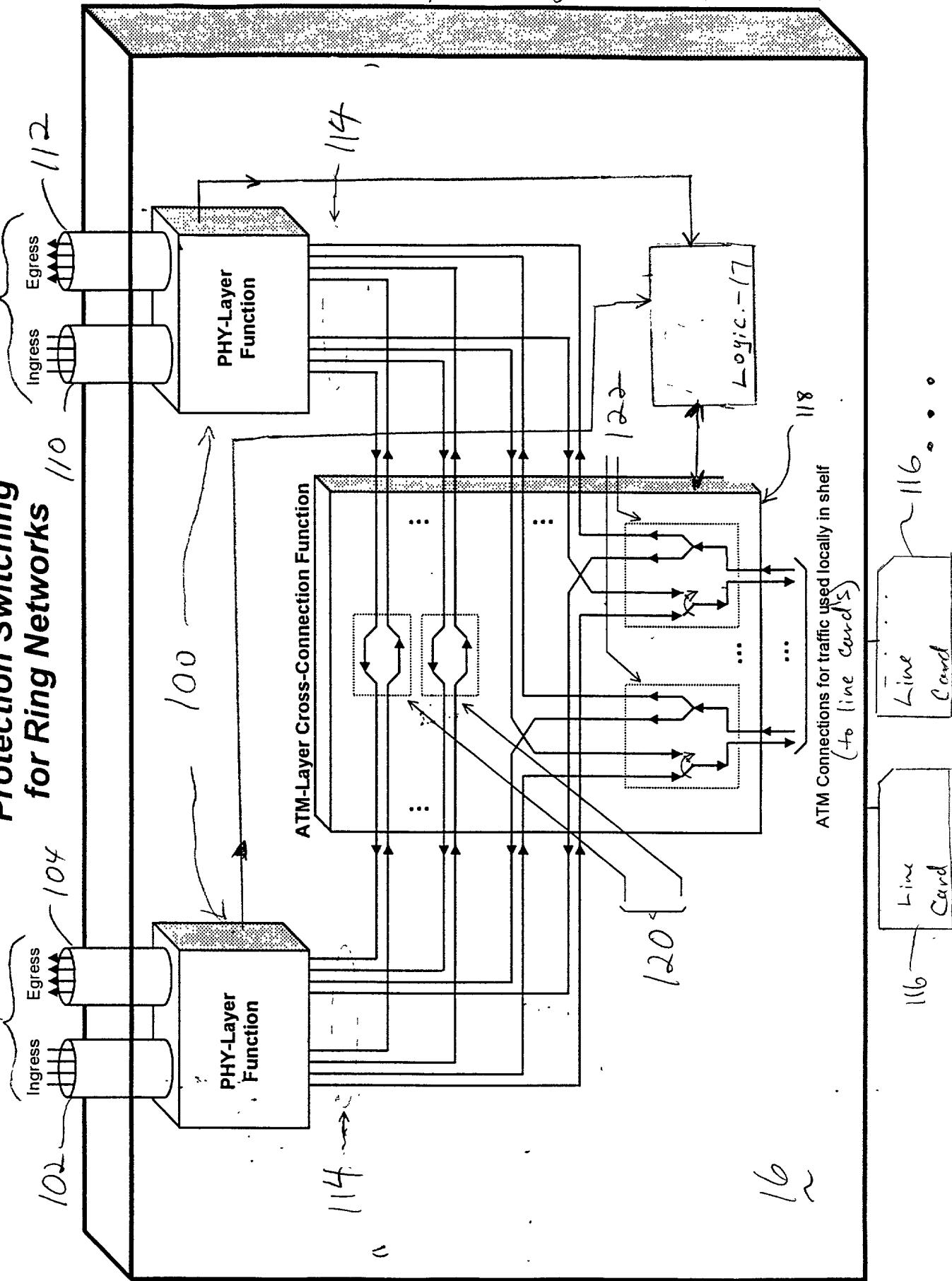


FIG. 2 106

## ATM Layer Protection Switching for Ring Networks



IN THE UNITED STATES  
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **REVERSE STATISTICAL MULTIPLEXING TO ACHIEVE EFFICIENT DIGITAL PACKING WITH LINK PROTECTION** the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

None

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Lester H. Birnbaum	(Reg. No. 25830)
Richard J. Botos	(Reg. No. 32016)
Jeffery J. Brosemer	(Reg. No. 36096)
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I hereby appoint the attorney(s) on ATTACHMENT A as associate attorney(s) in the aforementioned application, with full power solely to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected with the prosecution of said application. No other powers are granted to such associate attorney(s) and such associate attorney(s) are specifically denied any power of substitution or revocation.

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Case Name and No. Nadja 2-8-1 (8018-12) 4

Full name of 3rd joint inventor: **Allen M. Rush**

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**ATTACHMENT A**

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